# Design of Autonomous Quadrotor Behavior and Control for Swarm Formations

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## Overview

Recently, small radio-controllable aircraft known as quadrotors have become very popular. Their ability to lift payloads and perform precise maneuvers gives them much utility. When several quadrotors are networked together, this forms what we call a "swarm," which have a variety of possible applications. We will show how this can be accomplished.

## Operation

A quadrotor swarm proposes to share the knowledge between all of the quadrotors. In order for a quadrotor swarm to be effective, the participating quadrotors will need to establish situational awareness in respect to each other.

Each quadrotor is equipped with a processor and wireless transceiver. All followers will have a camera with an infrared light filter. The coordinator will have four infrared LED beacons.The coordinator will issue commands to the followers based on where they are and where they need to be.

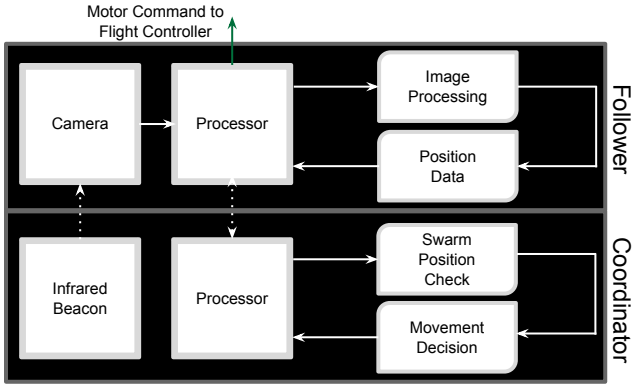


**Figure X:** Top-level swarm algorithm

## Innovation

Current swarms use cameras to see all the quadrotors requiring the use of and off-board coordination system. Our work aims to:

- place all computation and sensing into the swarm
- allow for formation changes and precise positioning
- provide a platform advanced swarm operation

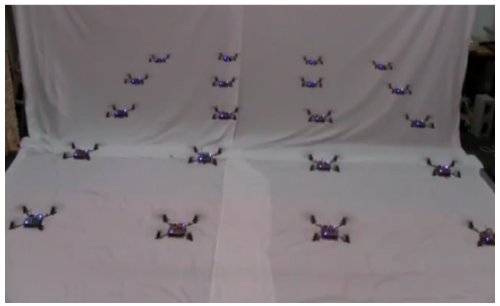

**Figure X:** UPenn quadrotor swarm uses an off-board coordination scheme (http://www.gizmag.com/)

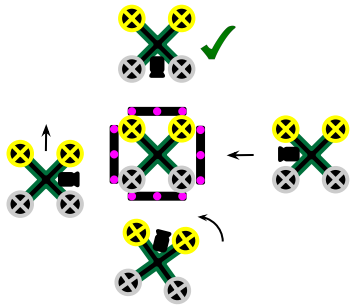

**Figure X:** Our swarm algorithm's fundamental operation

## Applications

In the future, quadrotor swarm functionality may become even more useful for other applications. The complex coordination that swarms can provide can be used for construction projects, delivery, autonomous surveillance or reconnaissance, and aerial video recording.

## Vision System

**Detection Algorithm:**

-The camera takes an image of the coordinator beacon

-The follower finds the location of the LEDs calculates the distances between them

-The LED distance can be used to determine the position of the follower

-This position information is stored for the communication system to use

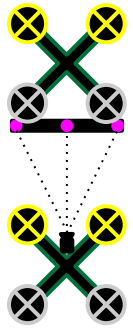

**Figure X:** Distance measurement

## Communication System

**Maintenance Algorithm:**

-The coordinator records position data for each quadrotor

-It will periodically send movement commands the followers if the followers are out of position

**Formation Algorithm:**

- The coordinator checks all of the current positions of followers

-It then calculates paths for the followers to take in order to prevent path crossing

-Finally, it will issues movement directives to each follower and return to the maintenance algorithm

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